

NASA TECH BRIEF

Langley Research Center



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Automated Monitoring of Recovered Water Quality

A laboratory prototype water quality monitoring system has been developed. The system (see Figure 1) was designed to provide an automatic system for online monitoring of the chemical, physical, and bacteriological properties of recovered water and for signaling a malfunction in the water recovery system. The parameters monitored and the ranges measured are: chloride ion, 10 to 1000 ppm; ammonium ion, 1 to 100 ppm; pH, 2 to 11; specific conductance, 1 to 1000 $\mu\text{mho/cm}$; total organic carbon, up to 100 ppm; and bacteria (*E. coli*), 10 to 5×10^3 cells/ml. Water sample size was 500 ml/hr, and the sensors were integrated into a total system with alarms and readouts.

This water monitor is a practical approach to assessing the potability of reclaimed water, incorporating whenever possible commercially available sensors suitably modified. These sensors are simple, reliable, able to operate in a flow system (up to 2 ml/min), and capable of withstanding pressure up to about 5 psig (136×10^3

N/m^2); each sensor has a direct readout and an output for remote monitoring. The sensor used for monitoring the bacteriological quality of recovered water does so by a chemiluminescence technique. Signals obtained for both incubated and unincubated bacterial samples permit differentiation between living and dead organisms, and a higher signal for the incubated sample indicates the presence of viable organisms.

The detection principle is based on measuring the increase in chemiluminescence produced by the catalytic action of bacterial porphyrins, specifically hematin, on a luminol-hydrogen peroxide mixture. Hematin is a substance found in most organisms, and the reaction is virtually instantaneous, occurring immediately on mixing the bacterial suspension with the aqueous reagents. Mixing is carried out within the view of a photomultiplier tube which monitors the light emitted by the reaction. The signals generated are directly proportional to the number of bacteria present.

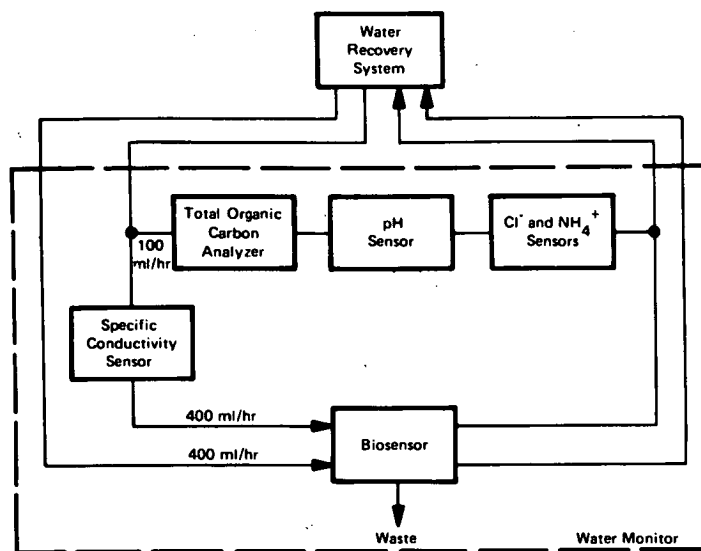


Figure 1. Closed-Loop Monitoring System

(continued overleaf)

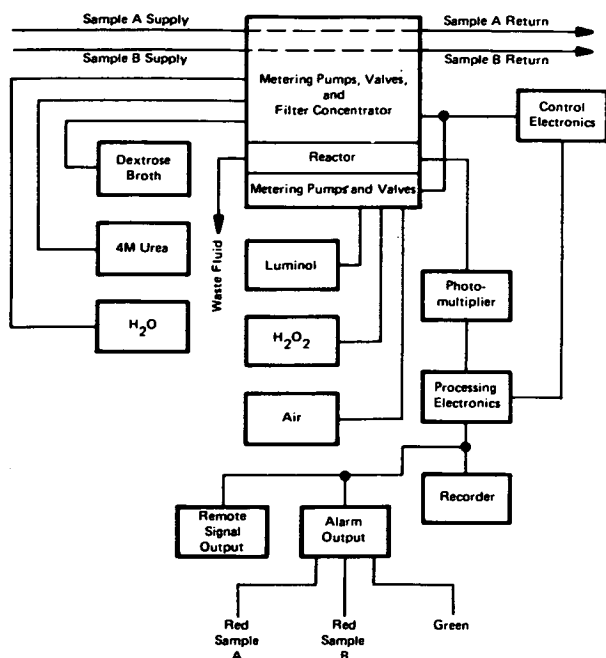


Figure 2. Biosensor Block Diagram

The biosensor is designed to monitor water from two sources independently (see Figure 2). Sample A water is processed for total bacterial content only. Sample B water may be processed for total bacterial content or for viable content. All sample processing paths (for both incubated and unincubated samples) which have been exposed to bacteria are flushed with a bactericide and filtered distilled water to minimize the possibility of contamination.

An 18-step programmer performs most of the process control. Each step on the programmer has an adjustable dwell time ranging from about 5 seconds to 10 minutes. The sampling step, 25 minutes, is the only step not falling within this time frame. Up to 20 functions are controlled during each step. Signals from the photo-multiplier tube are sent to the processing electronics and also provide a readout which is displayed on a strip-chart recorder for permanent record and analysis-of-data purposes.

Also sampled is the reagent baseline signal which is compared to the signal from the bacterial challenge.

When the signal exceeds a preset limit (over and above the reagent signal), an alarm light is turned on and remains on until a manual reset switch is activated.

The single paramount requirement of a water reclamation system is to provide water that is safe for human consumption, physiologically and psychologically. While a monitoring system itself cannot do this, its data can provide the governing criteria for judging water potability. Therefore the selection of parameters to be monitored is of prime importance.

No single set of requirements can be categorically considered as the ultimate in potability standards, but reasonable judgments must be made based upon many diverse factors. These include the individual and combined toxicologies of potential and bacteriological contaminants, the capabilities of the specific reclamation system, and its possible contribution of additional contaminants. A complete specification for general water quality must necessarily include numerous chemical, physical, and biological property requirements. On the other hand, a practical water quality monitor may be limited to only those contaminants that are toxic and that have a chance, to some acceptable level of probability, of being present during normal operation or through the malfunction of equipment. This water monitor will accomplish these functions.

Note:

Requests for further information may be directed to:
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NASA has decided not to apply for a patent.

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